

Review on Adoption Models of Technology and their Barriers on Businesses

Revisión sobre los modelos de adopción de tecnología y sus barreras en las empresas

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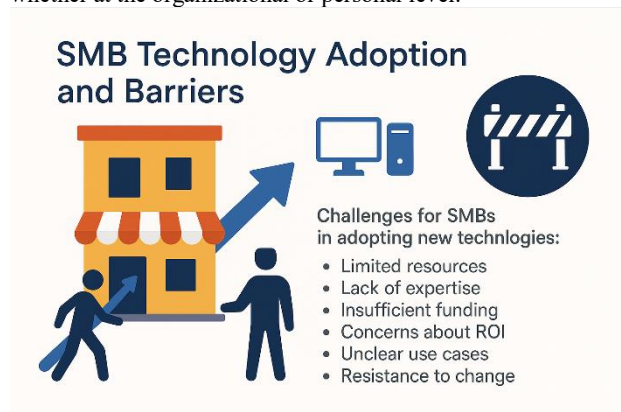
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Abstract

Small and medium sized businesses [SMBs] play a crucial role in emerging economies as they serve as the primary employer and source of development for individuals and society. SMBs face significant challenges in their development, and few manage to survive beyond 10 years to be considered established businesses. Typically, information technologies do not act as strategic partners for SMBs that support their growth and address business problems; they often remain completely separate from the business. Several reasons contribute to the lack of adoption of these technologies, including limited resources, lack of technical expertise, insufficient funding, concerns about return on investment, unclear use cases, and resistance to change. This research report aims to identify models that study how SMBs adopt new technologies and the barriers faced in this process, whether at the organizational or personal level.



Technology adoption models, Technology adoption barriers, small medium business [SMB], Small medium enterprises [SME]

Resumen

Las pequeñas y medianas empresas [PYMES] desempeñan un papel crucial en las economías emergentes, ya que son el principal empleador y fuente de desarrollo para las personas y la sociedad. Las PYMES enfrentan retos significativos en su desarrollo y son pocas las que logran permanecer más de 10 años para ser consideradas empresas establecidas. Por lo general, las tecnologías de la información no son un socio estratégico de las empresas que apoyen su crecimiento y resuelvan problemas de negocio, usualmente son totalmente separables del negocio. Entre las razones por las que estas tecnologías no son adoptadas están recursos limitados, falta de experiencia técnica, falta de recursos y preocupación sobre el retorno de inversión, falta de casos de uso claros y resistencia al cambio. Este reporte de investigación tiene como objetivo identificar modelos que estudien cómo las PYMES adoptan nuevas tecnologías y las barreras que enfrentan en este proceso, ya sea a nivel organizacional o personal.



Modelos de adopción de tecnología, Barreras de adopción de tecnología, Pequeñas y medianas empresas [PYME]

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Introduction

The Organisation for Economic Co-operation and Development [OECD] reports that Latin America and the Caribbean [LAC] faces a challenging macroeconomic landscape due to political transitions, socioeconomic situations, the COVID-19 pandemic, and the effects of Russia's aggression against Ukraine. Small and medium-sized businesses [SMBs] play a crucial role in LAC, constituting 99.5% of businesses and contributing approximately 60% of formal productive employment [*Índice de Políticas para PyMEs, 2024*].

The National Institute of Statistics and Geography [INEGI] [*Estudio sobre la Demografía de los Negocios (EDN) 2023, 2024*] reports that, in Mexico in 2019, 99.8% of the establishments in the country are micro, small, or medium-sized businesses. According to the Institute of Economic Research of Guadalajara [IEEG] [*Guadalajara, 2022*], SMBs represent approximately 70% of the GDP of the state of Jalisco.

Policies related to SMBs represent a critical area because, in most countries, the highest concentration of economic activity occurs within this sector. Additionally, these businesses possess significant potential to create jobs and foster shared prosperity on a large scale [Tewari et al., 2013].

Although the adoption of new technology creates opportunities in business by enabling what was previously impossible, it can also generate problems by disrupting the routines and processes that employees, such as system users, are accustomed to in conducting their tasks. Adopted technology is unpredictable and can negatively impact an organization, leading to situations where newly implemented systems may not be used effectively [Dube et al., 2020].

Many challenges continue to hinder the adoption of digital technologies by SMBs in developing economies. SMBs operating in the informal sector within emerging markets and developing economies [EMDEs] face similar obstacles that inhibit their ability to adopt advanced technologies and innovations necessary for improving business operations and re-engineering processes.

The technologies and technical innovations that appear novel in EMDEs have long been established in advanced economies. Most cutting-edge technologies, such as cloud computing, big data, and predictive analytics, which can significantly improve operations and strategic decision-making, have yet to gain traction in many EMDEs. Furthermore, SMBs largely underutilize disruptive computing technologies, data analytics, and the Internet of Things [IoT], despite these technologies' potential to help them develop innovative business models, reduce operational costs, strengthen competitive advantages, and advance digital transformation.

The limited adoption of digital technologies in EMDEs explains many businesses' significant challenges during the SARS-CoV-2 outbreak and the lockdowns imposed to contain the COVID-19 pandemic. To thrive in the "new normal" brought about by COVID-19 and intense global competition, successful adoption of advanced technologies becomes essential for these enterprises [Ikpe Justice Akpan & Adebisi, 2022].

One of the key recommendations from the OECD that applies generally to the LAC region is to promote the digitalization of SMBs through enhanced national digital strategies with well-defined implementation plans, emphasizing the development of broadband policies focused on SMBs to address specific challenges [*Índice de Políticas para PyMEs, 2024*].

Challenges facing SMBs in the LAC region exist as reported: in Peru, insufficient environmental education, a lack of business incentives, and limited IT resources constrain growth [Madrid et al., 2025]. In Ecuador, universities adopt cloud computing based on a combination of technological, organizational, economic, and security factors [Mero-Terán et al., 2025]. In Colombia, significant barriers to digital technology adoption include limited financial resources, resistance to organizational change, employees' lack of digital skills, and a technological infrastructure gap, particularly in rural areas [Linares et al., 2024].

This research report aims at identifying models that examine how SMBs adopt new technologies and the barriers faced in this process, considering both the organizational and personal level.

The present document is structured as follows. Section II introduces the theories, frameworks and models that examine technology adoption, and Section III presents the adoption barriers that businesses encounter when adopting new technologies. Finally Section IV presents the conclusions.

II. Theories, Frameworks and Models of Technology Adoption

According to Dube et al [Dube et al., 2020], technology adoption defines the initial use or acceptance of a new technology or system. Numerous theories, frameworks, and models for technology adoption identify, predict, and describe the variables that affect adoption behavior in both individuals and organizations. These factors typically fall into three categories: 1] Organizational factors, 2] Technological factors, and 3] Environmental factors [Hendricks & Mwapwele, 2024].

Some of this theories and models include: 1] technology acceptance model [TAM], 2] innovation diffusion theory [IDT], 3] the theory of reasoned action [TRA], 4] theory of planned behavior [TPB], 5] technology organization environment [TOE], and 6] unified theory of acceptance and use of technology [UTAUT]. Dube et al [Dube et al., 2020] finds that TAM, UTAUT, and TOE extensively apply to technology adoption at the organizational level. Many studies identify TAM as an effective leading model; it provides both theoretical and practical insights and serves as the most widely used framework by information systems [IS] researchers for predicting various users' acceptance of information technology [IT] in organizational contexts. TAM acts as a primary model for examining technology adoption at the organizational level.

Although UTAUT is designed to foresee technology adoption at the individual level, few studies explore its application at the organizational level. The TOE framework develops a theoretical perspective on technology adoption and the implementation of technological innovations. It offers a holistic view by considering both internal and external influences on technology adoption.

The IDT theories align with the organizational context and expertise found in the TOE framework.

A. Technology Acceptance Model [TAM]

Due to the lack of user acceptance of information systems, Davis develops the technology acceptance model [TAM] theoretical framework in 1986 [Davis et al., 1989]. This model predicts and explains how users accept and utilize new technologies. TAM builds on the theories of reasoned action [TRA] and planned behavior, distinguishing between principles, attitudes, beliefs, and intentions.

TAM calculates the perceived adoption of future behavior rather than actual behavior. The model focuses on two key constructs: perceived usefulness [PU] and perceived ease of use [PEU], as illustrated in Fig. 1. TAM identifies two factors that serve as determinants of behavioral intention [BI] to use new technology, which subsequently drives usage behavior [UB].

a) Perceived Usefulness [PU]. This construct refers to the degree to which a user believes that using a technology enhances their job performance. Essentially, when users perceive that a technology can help them achieve their goals more efficiently, they are more likely to adopt it.

b) Perceived Ease of Use [PEU]. This construct relates to the extent to which a user believes that using the technology requires minimal effort. When users perceive a technology as easy to use, it increases the likelihood of its acceptance.

Dube et al [Dube et al., 2020] points out that TAM has limitations, such as neglecting social influences and failing to account for external factors that might affect technology adoption.

B. Technology Organization Environment [TOE] framework

The technology organization environment [TOE] framework serves as a theoretical model that Tornatzky and Fleischer develop in 1990 [Tornatzky & Fleischer, 1990], aiming to understand the factors influencing the adoption and implementation of technological innovations within organizations.

According to Dube et al [Dube et al., 2020], the inclusion of organizational, technological, and environmental variables makes TOE advantageous compared to other models used to study technology adoption. This framework focuses on higher-level attributes rather than detailed behaviors of individuals within the organization. The three critical contexts that affect technology adoption are: organization, technology, and environment [Dube et al., 2020].

Dube et al [Dube et al., 2020] also mentions that the TOE framework has limitations because it does not represent an integrated theoretical framework or a well-established theory. Its broad nature can make it challenging to apply in specific contexts.

C. *Unified Theory of Acceptance and Use of Technology [UTAUT]*

The unified theory of acceptance and use of technology [UTAUT] serves as a comprehensive framework that Venkatesh et al. developed in 2003 [Venkatesh et al., 2003] to explain the factors influencing technology acceptance and usage.

Dube et al [Dube et al., 2020] notes that UTAUT enables analysis of users' intent to use an IS and the behaviors resulting from using an IS or technology. UTAUT categorizes four vital factors [Dube et al., 2020]: performance expectancy, effort expectancy, social influence, and facilitating conditions. It also identifies four moderators that can influence the relationships between these vital factors: age, gender, experience, and voluntarism. These moderators help explain variations in technology acceptance across different demographic groups and contexts.

Dube et al [Dube et al., 2020] finds limitations and challenges within UTAUT, noting that although many studies cite this model, only a small number actually utilize it. Furthermore, the subjective measures currently in use remain unvalidated, leaving their relationship to technology or system usage often unknown.

D. *Integrating Models*

Dube et al [Dube et al., 2020] concludes that integrating models to develop a new framework proves valuable, particularly when considering the limitations of various technology adoption models and theories.

As an example of model integration, Tongsuksai [Tongsuksai et al., 2023] combines the organizational [TOE] and individual [UTAUT] models, allowing for the inclusion of dimensions that each model does not cover.

III. Adoption Barriers

Adopting new technologies in small and medium-sized businesses [SMBs] offers numerous benefits, such as enhancing operational capabilities; however, companies face multiple challenges in this adoption process. In some cases, companies need to radically change individual mindsets, organizational design, and corporate strategic vision while implementing modern technologies that support new business objectives and customer requirements [Omran et al., 2024].

SMBs encounter significant challenges when implementing new technologies like AI, big data, or IoT. While larger companies often prepare better for adopting these technologies due to their greater resources and capabilities, many SMBs struggle to do the same [Omran et al., 2024].

Senna [Senna et al., 2022] studies the barriers to the adoption and implementation of Industry 4.0 technologies in the manufacturing sector. He identifies fourteen barriers to adopting these technologies, categorizing them according to the criteria of the TOE framework. Omran [Omran et al., 2024] identifies and analyzes factors that determine the adoption of digital technologies in SMBs, concluding that organizational drivers predominantly influence adoption over technological and environmental factors.

Various authors [Dube et al., 2020; *Examining the context-specific reasons and adoption of artificial intelligence-based voice assistants: A behavioural reasoning theory approach - Anayat - 2023 - International Journal of Consumer Studies - Wiley Online Library*, s/f; Hendricks & Mwapwele, 2024; Kinkel et al., 2022; Omran et al., 2024; Senna et al., 2022; Tongsuksai et al., 2023] identify barriers to technology adoption in SMBs according to the TOE framework.

This framework proposes that the decision to adopt an innovation is based on technological, organizational, or environmental contexts.

The relationship between these barriers and the TOE contexts are shown in Table I which is described below.

A. Organization

The organizational context refers to internal factors that serve as descriptive measures of the organization [Senna et al., 2022]. These measures include size, scope, organizational structure, managerial hierarchy, and financial resources [Dube et al., 2020]. The attributes within this context determine how an organization adapts to new technologies and its readiness for adoption. This context is crucial for understanding how organizational characteristics influence technology decisions.

B. Technology

The technology context encompasses the characteristics of the technology itself, both within the organization and those related to communications and information exchange outside of it [Senna et al., 2022]. It addresses the technologies currently in use by the organization as well as new technologies that may be relevant for adoption. This context significantly impacts how technological adoption occurs within an organization.

C. Environment

The environmental context refers to external factors that influence an organization's technology adoption decisions, such as the location where the organization operates and conducts its business, as well as relationships with clients and suppliers [Senna et al., 2022]. This context includes outside elements affecting the business, such as government incentives and competition [Dube et al., 2020].

Box 1

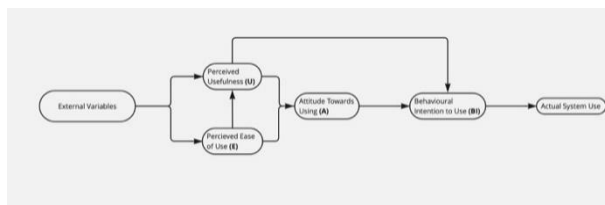


Figure 1
Technology Acceptance Model [TAM]
[Davis et al., 1989].

Box 2

Table 1

Adoption Barriers and their context	
TOE framework Context	Adoption barrier
Organization	Management support
Organization	Preparedness
Organization	Project champion
Organization	Organizational changes needed
Organization	Changing peoples minds, organization structure, strategic vision
Organization	Size
Organization	Access to financial resources
Organization	Hesitant when it comes to AI adoption
Organization	Requires employees with specific digital skills
Technology Environment	Infrastructure
Environment	Competition
Environment	External IT support
Environment	Government financing
Environment	IT skills
Environment	People in favor of adopting vs people against adopting

Box 3

Table 2

Integrative Review of Technology Adoption Models and Methods.

Cite	Cited Methods	Conclusions/Contributions
Dube, T., Van Eck, R., & Zuva, T. [2020].	Comprehensive reviews	The concept of an integrated model is endorsed by existing frameworks and hypotheses of innovation, which are slight significant in clarifying technological acceptance for the new technologies
Omriani, N., Rejeb, N., Maalouli, A., Dabić, M., & Kraus, S. [2022]	Descriptive and multivariate analysis techniques and ordered logit regression	The concept of an integrated model is endorsed by existing frameworks and hypotheses of innovation, which are slight significant in clarifying technological acceptance for the new technologies
Omriani, N., Rejeb, N., Maalouli, A., Dabić, M., & Kraus, S. [2022]	Descriptive and multivariate analysis techniques and ordered logit regression	The concept of an integrated model is endorsed by existing frameworks and hypotheses of innovation, which are slight significant in clarifying technological acceptance for the new technologies
Hendricks, S., & Mwapwele, S. D. [2024]	Qualitative research method Thematic analysis"	Although there are benefits to e-commerce adoption, if the management of organisations or the government in a developing country does not believe that e-commerce will be valuable and beneficial to them, then they may decide not to adopt it and thus cannot realise any of its benefits. Presenting a novel model of technology adoption that departs from TOE by adding the customer trust factor and performance factor
Anayat, S., Rasool, G., & Pathania, A. [2023]	Exploratory sequential mixed-method research design, which includes both qualitative and quantitative analysis of data	Comprehensive understanding of how consumers think about and make decisions regarding AI-based voice assistants

Tongsuksai, S., Mathrani, S., & Weerasinghe, K. [2023]	Qualitative data analysis was carried out using sentiment analysis" Integrative model based on the technological, organizational, environmental, and individual dimensions Qualitative research approach Case study as the research strategy for an enriched view	Investigated the characteristics for cloud ERP adoption in SMEs based on a combined TOE and UTAUT model to provide a more holistic view
Kinkel, S., Baumgartner, M., & Cherubini, E. [2022]	International online survey Regression model using natural logarithm	Internal organizational factors provide a higher explanatory contribution to the adoption of AI technologies in production than technical production factors or conditions of the external environment Innovation capabilities and digital skills contribute to the introduction of AI technologies not only at a company's home base, but also at its foreign locations The measurement of strategic competition factors as part of a company's internal organizational capabilities
Senna, P. P., Ferreira, L. M. D., Barros, A. C., Roca, J. B., & Magalhães, V. [2022]	Structural Modelling [ISM] methodology Matrix Impact of Cross Multiplication Applied to Classification [MICMAC] analysis	Identified 14 barriers to the adoption of I4.0 technologies Focusing on environment dimension barriers could prove to be a good prioritization strategy, given that these barriers had lower degrees of dependency and higher degrees of driving power when compared to all the organizational barriers, as well as to all but one of the technological barriers It identifies the set of barriers and categorizes them into the TOE framework It provides an analysis of the interrelationships between the barriers to adopt I4.0 technologies and identification of root barriers
Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. [1989]	Empirical Study	Although ease of use is clearly important, the usefulness of the system is even more important and should not be overlooked
Olimjanovich, D., Nodirovna, M., & Ugli, M. [2024]	Literature review	Governments can support small business and private entrepreneurship growth and development by creating a supportive business environment, ensuring access to finance, encouraging training and capacity building, encouraging innovation and technology, and facilitating internationalisation. By implementing these strategies in accordance with international standards, governments can support the development of small businesses and private entrepreneurship, and contribute to the overall economic development of their countries.

Methodology

This review examines the state of the art on technology adoption models, focusing on information technology and, where possible, their applicability to Mexico or similar economies.

We conduct the initial search in autumn 2024 on Google Scholar and IEEE Xplore, using the keywords "technology adoption models" and "technology adoption barriers." We further explore recent publications from 2020 onward, concentrating on the application of these models to small and medium businesses [SMBs] or small and medium enterprises [SMEs]. Additionally, we investigate subsequent publications by the first or second authors of identified papers to uncover further advancements in the field.

We also examine authors citing papers that reference the topics of interest. The inclusion criteria for article selection include technology adoption models, technology adoption barriers, SMBs, SMEs; publications from 2020 to 2024 that either cite or are cited by the selected papers.

Despite searching for current research on technology adoption by SMBs in Mexico or Latin America, we find no relevant studies. Based on these criteria, we deem 15 articles suitable for inclusion. Table 2 references the methods used in these articles.

Conclusions

The barriers to technology adoption in SMBs are revealed to persistently affect both organizational structures and individual actors. Models at both the organizational and individual levels, alongside barriers arising from technological, organizational, and environmental contexts, are analyzed, demonstrating that no single model, framework, or theory is sufficient to fully capture the complexities of the adoption process.

It is suggested by the findings that a more comprehensive understanding of this multifaceted phenomenon is offered by integrating models from both organizational and individual perspectives.

The advantage of such an integrated approach is identified in its capacity to evaluate individual-level factors together with technological, organizational, and environmental dimensions, thereby providing a holistic view of the technology adoption process. Future research should be aimed at identifying optimal combinations of models to better explain the barriers to digital technology adoption among SMBs in Latin America and the Caribbean [LAC].

Declarations

Conflict of interest

The authors declare no interest conflict. They have no known competing financial interests or personal relationships that could have appeared to influence the article reported in this article.

Author contribution

Rodolfo Luthe conceived the original idea for the paper. Gabriela Calvario and Álvaro Parres contributed to the design of the study and participated in the writing and revision process. All authors were involved in the development of the manuscript and approved the final version.

Availability of data and materials

This study is based on a literature review; no new data were generated. All sources are properly cited in the manuscript.

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Abbreviations

List abbreviations in alphabetical order.

BI	Artificial Neural Network
CONAHCYT	Consejo Nacional de Humanidades Ciencias y Tecnologías
EMDEs	Emerging Markets and Developing Economies
IS	Information Systems
IT	Information Technology
IDT	Innovation Diffusion Theory
IIEG	Institute of Economic Research of Guadalajara
IoT	Internet of Things
LAC	Latin America and the Caribbean
INEGI	National Institute of Statistics and Geography
OECD	Organisation for Economic Co-operation and Development
PEU	Perceived Ease of Use
PU	Perceived Usefulness
SMBs	Small and Medium Sized Businesses
SMB	Small Medium Business
SME	Small Medium Enterprises
TAM	Technology Acceptance Model
TOE	Technology Organization Environment
TPB	Theory of Planned Behavior
TRA	Theory of Reasoned Action
UTAUT	Unified Theory of Acceptance and Use of Technology
UB	Usage Behavior

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